

# Pulmonary Function Tests

- **Used for:**

1. Dx different types of lung processes
  - Restrictive vs. obstructive
2. Assessment of disease severity
  - Pre-op
3. Post-treatment evaluation
  - Drug efficacy, etc.

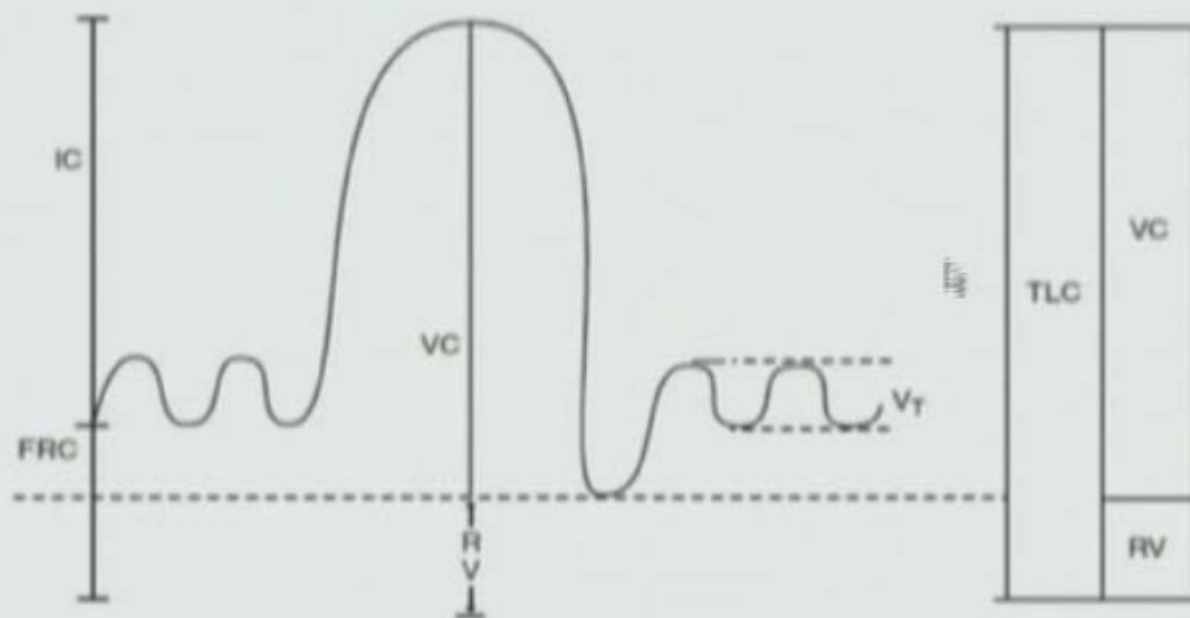
# Lung Volumes

- **Remember:**
  - When we determine **lung volumes**, we measure lung function under **static conditions**.
- Allows the diagnosis of **restrictive lung disease**.

## Pulmonary Indices

Index	Acronym	Description
Total lung capacity	TLC	Volume of gas in the lungs after maximal inspiration
Residual volume	RV	Volume of gas remaining in the lungs after forced maximal expiration
Vital capacity	VC	The volume of gas exhaled with maximal forced expiration $TLC = RV + VC$ or $VC = TLC - RV$

# Determination of Lung Volumes



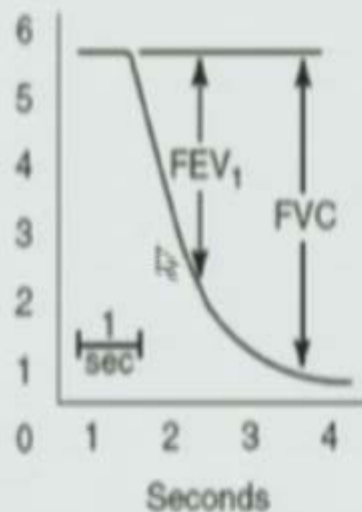
IC, inspiratory capacity; FRC, functional residual capacity;  $V_T$ , tidal volume; inspiratory residual volume.

# Forced Expiratory Flow

- Remember:
  - When we determine **'expiratory' flow** and **'expiratory' volumes**, we measure lung function under **dynamic conditions**.
- Allows the diagnosis of **obstructive lung disease**.

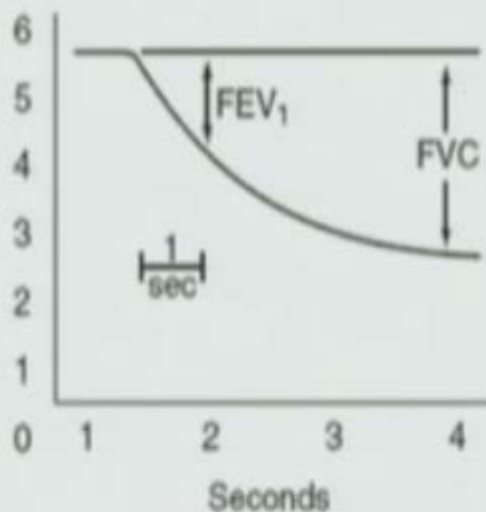
# Forced Expiratory Volumes

NORMAL



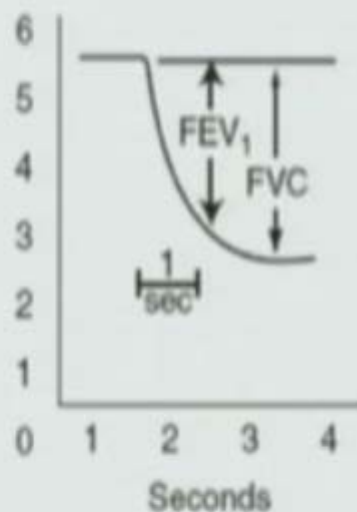
$FEV_1 = 4.0$   
 $FVC = 5.0$

OBSTRUCTIVE



$FEV_1 = 1.3$   
 $FVC = 3.1$

RESTRICTIVE

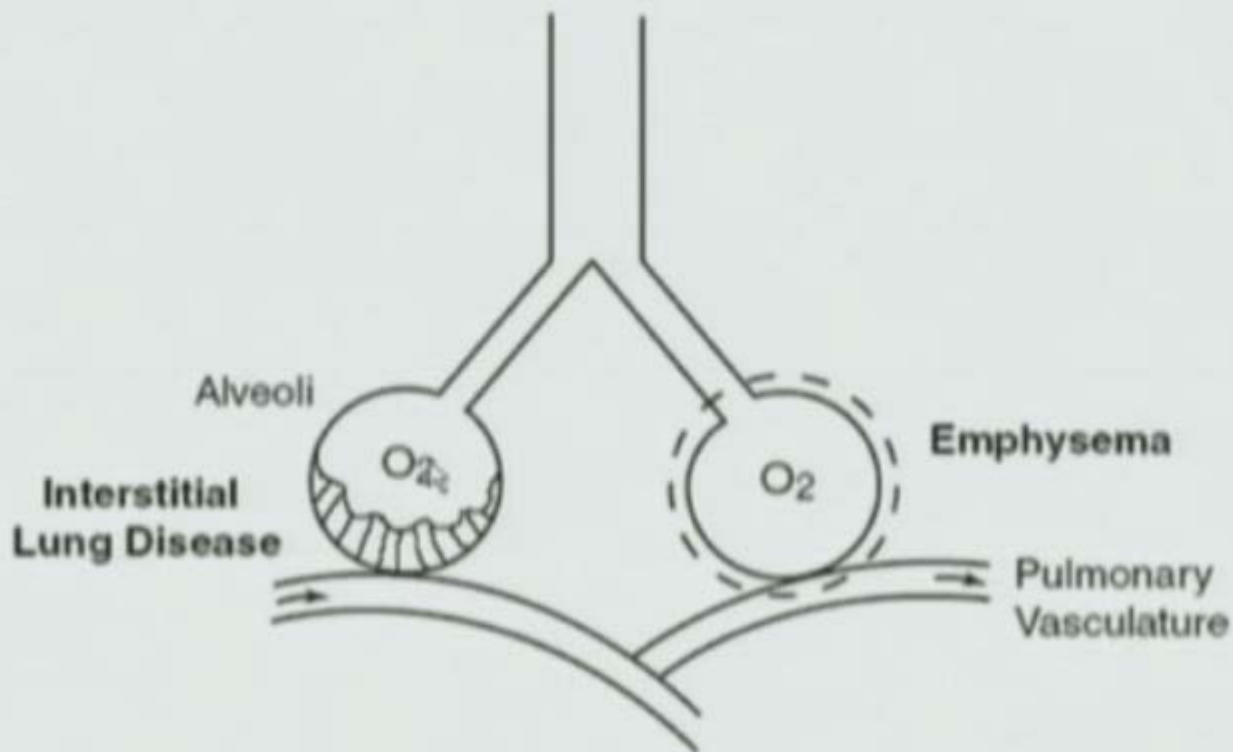


$FEV_1 = 2.8$   
 $FVC = 3.1$

## Bottom Line

- **Restrictive disease:**
  - Low TLC, low RV, low VC
- **Obstructive disease:**
  - Low FEV1/FVC, low FEF 25-75%
  - +/- elevated RV, elevated TLC
- Anything less than 80% (0.80) predicted is considered low.

# Alveolar Diffusing Capacity





# Bottom Line

- **Decreased**
  - Emphysema
  - Interstitial lung disease
- **Normal**
  - Chronic bronchitis
  - Extra-pulmonary restriction
- **Increased**
  - Alveolar hemorrhage

# Other Tests

## 1. Methacholine challenge

- Bronchoprovocation
- Evaluation of patients with **normal** PFTs
- Positive test: 20% decrease

## 2. Bronchodilator reversibility

- Evaluation of patients with PFTs showing an **obstructive pattern**

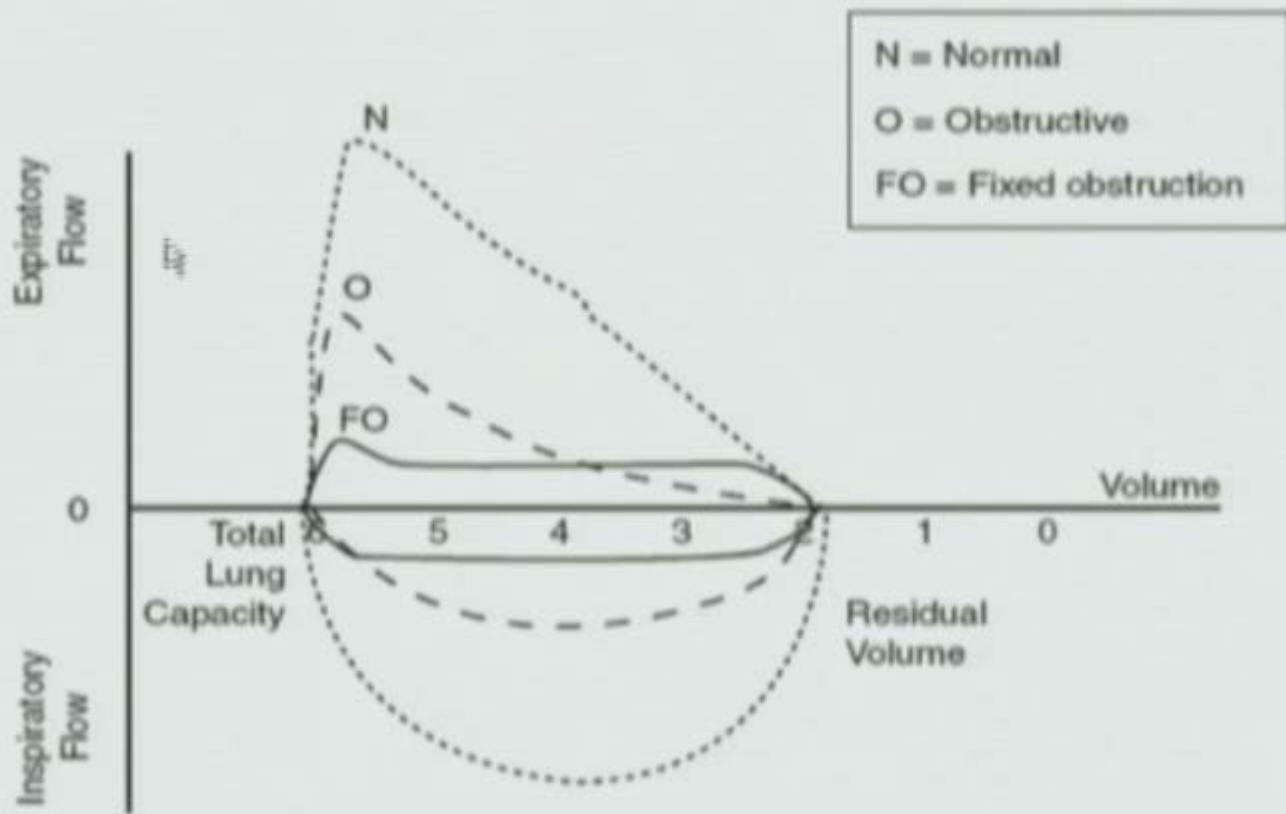
## Table I-10-2: PFT Questions

PFT Indices	Patient 1	Patient 2
TLC	87%	55%
RV	120%	50%
VC	90%	50%
FEV <sub>1</sub> /FVC	80%	90%
FEF <sub>25%-75%</sub> (MMFR)	50%	90%
DLco	Patient 1a: 90% Patient 1b: 40%	Patient 2a: 90% Patient 2b: 40%
What is your diagnosis?		

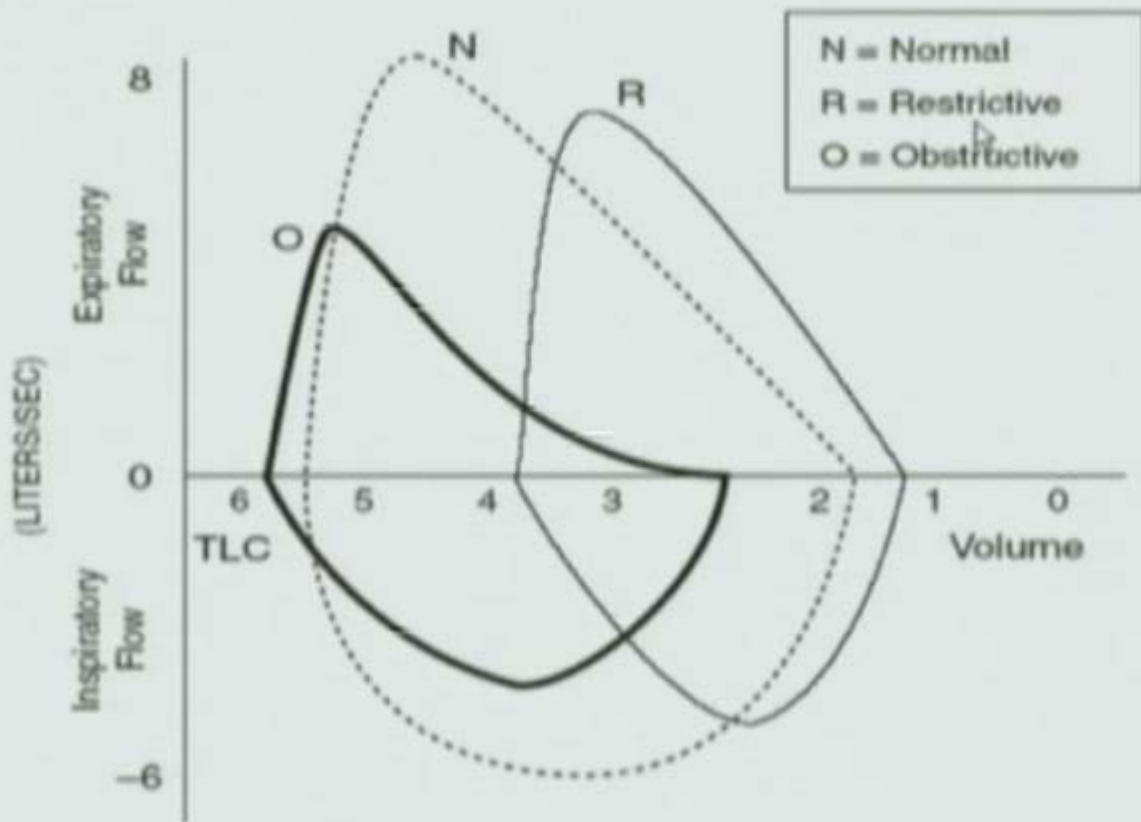
# Flow Volume Loops

- Express relationship between flow rates versus lung volumes in different lung processes
- **Know:**
  1. Obstructive pattern
  2. Fixed airway obstruction
    - Tracheal stenosis
  3. Dynamic airway obstruction
    - Vocal cord paralysis

# Flow-Volume Loop



# Flow-Volume Loops





## **DISTURBANCES IN GAS EXCHANGE**

# Gas Exchange

- Oxygen delivery:

$$DO_2 = CO \times 1.34 \times Hb \times sat + 0.0031 \times PaO_2$$

- Alveolar-arterial Gradient:

$$A-a \text{ gradient} = (150 - 1.25 \times PaCO_2) - PaO_2$$



## ABG Case

- A 65-year-old man is admitted with dyspnea and SOB.
- **ABG:** 7.54/20 ( $\text{CO}_2$ )/60 ( $\text{O}_2$ )/ 92%
- **A-a gradient:**  
150 - 1.25  $\text{CO}_2$  -  $\text{O}_2$   
150 - 25 - 60  
150 - 85  
65



MEDICAL

## CHEST RADIOGRAPHY

# Chest Radiography

A 26-year-old man has a 2.5 cm calcified nodule in the right lung found on a routine chest x-ray.

He has no complaints. He has never smoked and his exam is unremarkable.

What is the next step?

# Pulmonary Nodules

- Always get an old x-ray first.
- **Low risk:**
  1. Follow-up with chest x-rays Q 3 months for 2 years
- **High risk:**
  - Open-lung biopsy and remove nodule
- **Be careful!**

Non-diagnostic bronchoscopy results in high-risk patients.

## Pleural Effusion Case

A 67-year-old man presents with dyspnea and pleuritic chest pain over 1 month.

He also has noticed 20 lb weight loss.

You find decreased air entry in the right lower lobe.

A chest x-ray shows a pleural effusion, with a decubitus x-ray showing free flowing fluid of approximately 3 cm.

What is the next appropriate step?

## Effusion/Serum Ratios

	Transudative	Exudative
LDH effusion	<200	>200
LDH effusion/serum	<0.6	>0.6
Protein effusion/serum	<0.5	>0.5

# Pleural Effusions

- Definitions:
  - Parapneumonic effusion
  - Hemorrhagic effusion
  - Lymphocytic exudative effusion
  - Malignant pleural effusion

# Evaluation of Respiratory Distress

- Do ABC's first and give O<sub>2</sub>
- Evaluation:
  - Chronic vs. acute
- Physical exam
  - RR!
- Labs
  - ABG
  - Chest x-ray
    - Normal chest x-ray!
  - B-type natriuretic peptide



# Admission to ICU and Intubation

- Persistent hypoxemia
- Increasing oxygen demands
- Hypercapnea in asthma
- Upper-airway injury
  1. Burns
  2. Laryngeal edema
- Altered mental status
- Neurologic depression



## **Obstructive Diseases: Asthma**

## Asthma

A 26-year-old woman with h/o asthma presents to the ED with 3 days of progressive SOB.

Meds: inhaled albuterol and over-the-counter (OTC) cold medications

RR 28, pulse (P) 110, and she is afebrile

Right nasal turbinate is edematous

There is evidence of wheezing throughout both of her lungs.

After you give her supplemental O<sub>2</sub>, what should we do next?

# General Concepts

- Inflammatory hyper-reactivity
- Reversibility
- Episodic
- Usually history of early onset
- Idiosyncratic versus extrinsic (atopic)
- Most common precipitants:
  1. Viral infections
  2. Drugs (asa, beta-antagonists)
  3. Exercise

# Presentation

- Tachypnea
- Wheezing
- Accessory muscles
- Diminished breath sounds
- Intercostal retractions
- Diaphoresis
- Pulsus paradoxus ( $> 20$ )
- Atypical presentations:
  1. Nocturnal cough
  2. Exercise-induced

# Evaluation

- Acute exacerbation
  1. ABG
  2. Chest x-ray
  3. Pulse oximeter
- Chronic phase evaluation
  1. PFTs to confirm diagnosis
  2. Methacholine challenge (if PFTs are normal)
  3. Peripheral eosinophilia?

# Treatment

- Acute exacerbation
  1. Oxygen
  2. Beta-agonists (short-acting): albuterol MDI or nebulizer
  3. Anticholinergics (less effective)
  4. Steroid spurt (start intravenously, then transition to oral )
- Chronic treatment
  1. Daily inhaled steroids
  2. MDI beta-agonists as needed



## Treatment (cont.)

- Long-acting beta-agonists
- Chronic systemic steroids
- Leukotriene modifiers (montelukast, etc.)
- Cromolyn, nedocromil
- Catecholamines (epinephrine)
- Aminophylline, theophylline



## Modified Guidelines

- Mild asthma
  1. <2 times/week, minimal night symptoms
  2. Inhaled albuterol as needed
- Moderate asthma
  1. Most of the week, may be daily, night symptoms
  2. Inhaled steroids and albuterol
- Severe asthma
  1. Symptoms despite treatment, hospitalizations
  2. **Regular Tx** and long acting beta-agonists, anti-leukotriene drugs, oral steroids

## Asthma Cases

A 26-year-old woman with h/o asthma presents to the ED with 3 days of progressive SOB.

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RR 28, P 110, and she is afebrile.

Right nasal turbinate is edematous.

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After you give her supplemental O<sub>2</sub>, what should we do next?

## Asthma Cases (cont.)

- There are clinical signs and symptoms, and laboratory findings that are associated with poor prognosis.
- Compare these ABGs:
  - 7.32/45/60 versus 7.45/30/50
- Discharge medications:
  - Albuterol and inhaled steroids
  - Tapering dose of oral steroids
- Out-patient clinic medications:
  - Albuterol and inhaled steroids

## Asthma Cases (cont.)

A 32-year-old man with h/o asthma comes to you for evaluation of moderate to severe asthma.

He takes inhaled fluticasone, inhaled salmeterol, and albuterol for breakthrough symptoms.

His physical exam discloses a left nasal polyp and mild expiratory wheezing.

## Asthma Cases (cont.)

A 22-year-old woman, with no prior medical history, comes for the evaluation of coughing during the night. She reports a dry cough that wakes her up during the night 3-4 times per week for 4 months.

She does not have post-nasal drip, heartburn, morning hoarseness, or halitosis.

A 4-week trial of omeprazole has not improved her symptoms.



## Asthma Cases (cont.)

A 28-year-old woman reports episodes of coughing after she completes her 2 mile run.

She has also experienced similar symptoms when she is exposed to cold weather.

Her primary care physician was concerned about exercise-induced asthma but the PFTs were “normal.” The physical exam is unremarkable.

## Asthma Cases (cont.)

A 42-year-old woman comes for evaluation of wheezing “off and on” for the past year.

She reports a dry cough along with the wheezing but feels otherwise well.

She was a 20 packs/year smoker and quit 12 months ago.

The exam is significant for mild expiratory wheezing throughout both lungs.

PFTs: obstructive pattern with decreased DLco.

## Asthma Cases (cont.)

A 27-year-old man with asthma comes to the clinic for evaluation.

He has symptoms of asthma almost every day and has been to the ED 2 times over the past six months.

He uses inhaled albuterol over 5 times/day to control symptoms.

He also takes inhaled triamcinolone and prednisone 20 mg daily.

His exam is significant for diffuse wheezing.



## Asthma Cases (cont.)

A 26-year-old woman with h/o asthma will be admitted to the hospital because of an asthma exacerbation.

Her chest x-ray shows hyperinflated lungs and flattened diaphragms but no infiltrate.

ABG: 7.2/65/60

You are the admitting physician in the ED and have to make a decision on the level of care.

## Asthma Cases (cont.)

A 22-year-old woman with asthma is admitted to the hospital for asthma exacerbation. Her asthma has taken a turn for the worse over the past few months.

Her chest x-ray shows bilateral upper lobe infiltrates.

Total serum IgE is elevated; eosinophilia is present.

Prick test (cutaneous reactivity) is positive to *Aspergillus*. *Aspergillus* antibodies (IgG) are positive in the serum.

## Asthma Cases (cont.)

A 20-year-old woman with new-onset asthma is admitted to the hospital for “asthma exacerbation.”

Two months prior, serum IgE and eosinophils were both elevated.

The chest x-ray on admission shows multiple infiltrates.

Creatinine is elevated and urinalysis shows red blood cells (RBCs) and protein.

## Asthma Cases (cont.)

A 60-year-old man is brought to the ED with fever and cough over 3-4 days.

His medical history is significant for hypertension, dyslipidemia, and CVA.

He has a 40 packs/year smoking history.

He takes atorvastatin, HCTZ, lisinopril, Dilantin<sup>®</sup>, and aspirin.

When examining him, you find right lower lobe wheezing.



**Obstructive Diseases:  
Chronic Obstructive Pulmonary Disease  
(COPD)**



## COPD

A 67-year-old woman with COPD is evaluated for dyspnea.

She denies fever but has productive cough.

Her medication is inhaled ipratropium.

She has a 32 packs/year smoking history.

RR 32, P 106, afebrile

PE:

- Cachectic
- Rapid breathing
- Distant heart sounds
- Increased AP diameter
- Expiratory wheezing

# General Concepts

- Emphysema
- Chronic bronchitis
- Nonreversible obstruction
- “Noninflammatory” conditions in the chronic state
- Significant inflammation during acute exacerbations
- Cigarette smoking
- A1-antitrypsin deficiency

# Presentation

- Wheezing
- Dyspnea
- Productive cough for a few months for consecutive years
- PE:
  - Distant heart sounds
  - Rhonchi, wheezing
  - Clubbing
  - Cor pulmonale
  - Facial plethora



# Testing

- Chest x-ray
  - Hyperinflated lungs
  - Flattened diaphragms
  - Slender heart
- ABG
  - Hypercapnia, hypoxemia
  - "60-60" group
- Labs
  - Polycythemia
- PFTs
  - Nonreversible obstruction

# Chronic Management

- Anticholinergics
  - Inhaled ipratropium
  - Most effective bronchodilator in COPD
- Beta agonists:
  - Inhaled albuterol
  - Less effective and more side effects
  - Avoid long-acting beta agonists
- Theophylline
  - Add ONLY if above Tx not sufficient

## Chronic Management (cont.)

- **Increase survival** and reduce mortality:
  - Smoking cessation
  - Home O<sub>2</sub> supplementation
    - PaO<sub>2</sub> ≤ 55
    - PaO<sub>2</sub> ≤ 59 and cor pulmonale
    - Desaturate with exercise
  - Vaccines
    - Influenza vaccine yearly
    - Pneumococcal vaccine Q 5 years
    - *H. Influenza* once a lifetime

# Management in Acute Exacerbation

- ABG
- O<sub>2</sub> saturation by pulse oximetry
- Chest x-ray
  - Exclude pneumonia and other lung processes (effusions, atelectasis)
- Theophylline levels
  - Careful when using macrolides
- Other:
  - CBC
  - Chemical profile
  - ECG exclude atrial fibrillation

## Management in Acute Exacerbation (cont.)

- **Admit to hospital** if changes of  $\text{CO}_2$  or  $\text{O}_2$  from baseline are significant, symptoms are severe, or you suspect pneumonia.
- All patients with COPD exacerbation who are on **home  $\text{O}_2$**  are usually admitted to the hospital.
- Consider **intubation** if the patient has an altered level of consciousness or is hemodynamically unstable.

# Treatment in Acute Exacerbation

- **O<sub>2</sub> supplementation** ~ 90% saturation
- **Bronchodilators**
  - Ipratropium and albuterol
  - MDI or nebulizer
- **Systemic corticosteroids**
  - Spurt dosing and then taper
- **Antibiotics**
  - Despite “normal x-ray”
  - Macrolides, cephalosporins, fluoroquinolones



## Treatment in Acute Exacerbation (cont.)

- Don't stop theophylline if the patient is taking it.
- Don't start theophylline if the patient is NOT taking it.
- Avoid sedatives, opiates.
- Counsel on tobacco cessation before discharge from the hospital.
- Counsel on optimal way to use MDIs.

## PFTs in COPD

- **Always confirm** the diagnosis of COPD by PFTs.
- FEV1 is the best predictor of survival
  - FEV1 < 25% = severe
  - FEV1 = 25-50% = moderate
- **Don't do** PFTs after a recent or during COPD exacerbation.
- **Always do** PFTs in a COPD patient scheduled for lung surgery to assess the extent of disease.



## COPD Cases

A 67-year-old woman with COPD is evaluated for chronic dyspnea.

She denies fever but has productive cough.

Her medication is inhaled ipratropium.

She has a 32 packs/year smoking history.

RR 32, P 106, afebrile

PE:

- Cachectic
- Rapid breathing
- Distant heart sounds
- Increased AP diameter
- Expiratory wheezing

## COPD Cases (cont.)

- PFTs: evidence of non-reversible obstruction
- She wants to know “how bad her lung disease is:” check FEV1
- Treatment:
  - Ipratropium
  - Assess for home O<sub>2</sub>
  - Smoking cessation
  - Vaccines
  - ? and beta-agonist
  - ? and theophylline

## COPD Cases (cont.)

A 72-year-old man with chronic bronchitis comes to the ED with dyspnea and cough over 2 days.

COPD had been stable until recently, with a prior hospitalization 8 months ago.

PMHx: HTN, dyslipidemia

SHx: 42 packs/year smoking

Medications: inhaled ipratropium t.i.d., lisinopril, HCTZ, simvastatin, and continuous O<sub>2</sub> 1L nc

## COPD Cases (cont.)

- RR 22, P 126, afebrile
- PE:
  - Distant heart sounds
  - Increased AP diameter
  - Expiratory wheezing
  - JVD is 10cm
  - Peripheral edema is 2+ to the knee

## COPD Cases (cont.)

1. What is the next step?
2. What are the first test(s) to do?
3. Why will this patient get admitted to the hospital?
4. Why would an ECG and BNP be particularly helpful in this patient?
5. If the chest x-ray shows no evidence of pneumonia, do we still start antibiotics?
6. In this case, when would you consider doing PFTs during the hospital admission?



## COPD Cases (cont.)

A 37-year-old man comes for the evaluation of elevated transaminases that were found on routine lab tests.

PMHx: COPD over 2 years

SHx: 10 packs/year smoking, quit 7 years ago

Medication: inhaled ipratropium t.i.d.

RR 16, P 92, afebrile

PE: Mild expiratory wheezing involving the lower lobes

CT chest: lower lobe emphysematous changes



## **Obstructive Diseases: Bronchiectasis**

# Bronchiectasis

A 17-year-old woman is admitted to the hospital with right lower lobe pneumonia.

She has h/o prior pneumonias and multiple admissions to the hospital.

She also has a chronic daily productive cough as well as chronic diarrhea.

PE:

- Thin
- Respiratory distress
- Lung exam: diminished breath sounds on the RLL



## Bronchiectasis (cont.)

- Permanent dilation of bronchi
  - Local versus diffuse
- Presentation
  - Purulent copious sputum
  - Recurrent pneumonias
  - Gram-negative pneumonias
  - Hemoptysis
- Diagnose
  - Chest x-ray
  - High resolution CT scan (best noninvasive test)

## High Resolution CT: Bronchiectasis



# Bronchiectasis (cont.)

## Treatment

1. Acute pneumonia
  - Antibiotics for pseudomonas
2. Chronic
  - Bronchodilators
  - Chest physical therapy, postural drainage
  - Rotate antibiotics
  - Vaccinations
  - Surgery for localized disease

## Bronchiectasis Case

A 17-year-old woman is admitted to the hospital with right lower lobe pneumonia.

She has a h/o prior pneumonias and multiple admissions to the hospital.

She also has chronic daily productive cough as well as chronic diarrhea.

**PE:**

- Thin
- Respiratory distress
- Lung exam: diminished breath sounds on the RLL



## INTERSTITIAL LUNG DISEASES

# Interstitial Lung Diseases

- Chronic inflammation >>>>
- Fibrosis of the interstitium >>>>
- Gas exchange is disrupted >>>>
- Hypoxemia
- Similar clinical symptoms
  - Exertional dyspnea
  - Fine crackles
  - Clubbing
  - Cor pulmonale

## Interstitial Lung Diseases (cont.)

- Similar x-ray findings
  1. Reticular pattern
  2. Ground-glass appearance
- Similar PFTs
  1. Intrapulmonary restrictive lung disease
  2. Decreased DLco
- Similar work-up (after initial chest x-ray)
- High-resolution CT scan
- Biopsy



# Interstitial Lung Diseases (cont.)

Causes (over 100 diseases):

- Idiopathic pulmonary fibrosis
- Sarcoidosis
- Occupational lung disease
- Silicosis, asbestosis, etc.
- Autoimmune disease
- Wegener granulomatosis
- Hypersensitivity pneumonitis
- Eosinophilic pneumonia
- Churg-strauss syndrome

## IPF Case

A 55-year-old man comes for evaluation of dyspnea with exertion over 6 months.

He says that recently, walking across the room has become difficult.

He has no significant past medical history.

RR 24, P 106

PE:

- Positive JVD
- Lung exam: fine crackles on inspiration
- Positive clubbing
- Positive trace edema

Chest x-ray: diffuse reticulonodular pattern

# IPF

- Chronic lung inflammation
- Unknown etiology
- Involves only the lung
- Usually fifth decade of life
- Presentation is typical ILD
- PFTs: restrictive lung disease
- Bronchoscopy and lavage are nonspecific but exclude other diseases
- Tx: steroids? Approximately 20% respond

## IPF Case

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He says that recently, walking across the room has become difficult.

He has no significant past medical history.

RR 24, P 106

# IPF Case

PE:

- Positive JVD
- Lung exam: fine crackles on inspiration
- Positive clubbing
- Positive trace edema

Chest x-ray: diffuse reticulonodular pattern

Bronchoscopy and lavage:

- No granulomas
- Chronic inflammation with increased macrophages

## IPF Case (cont.)

You have made the diagnosis of IPF in the previous patient based on the bronchoscopy results excluding other diseases.

After discussion with the patient and his family you have decided to start oral **prednisone** at 60 mg daily and make an appointment to see him after 3 months.

What is the **best f/u test for response** to Tx?



## Sarcoidosis Case

A 27-year-old woman comes to your office with painful erythematous papules. She also has had joint swelling for a few days.

PE discloses symmetrical polyarticular arthropathy and well-demarcated 3 cm papules over the anterior leg area.

What would a chest x-ray be consistent with?



# Sarcoidosis

- Chronic granulomatous disease
- Noncaseating granulomas
- Lung most commonly involved
- Hilar adenopathy: asymptomatic
- Other:
  - Skin
  - Eye
  - Joints
  - Central nervous system
  - Peripheral nerves
  - Gastrointestinal system
  - Kidney

## Sarcoidosis (cont.)

- Laboratory:
  - Hypercalcemia
- Prognosis:
  - 80% lung lesions improve without Tx
- Diagnosis: biopsy of involved tissue
  - Noncaseating granulomas
  - Do NOT use ACE levels
- Treatment: steroids
  - Eye, central nervous system, hypercalcemia, ?lung

## Sarcoidosis Case

A 27-year-old man is found to have bilateral hilar adenopathy on a routine chest x-ray taken before starting his new job.

He has no symptoms and feels well overall.

PE and lab tests are unremarkable.

Plan:

- Watch for now and follow up in a few months.



# Pneumoconiosis

- Occupational lung diseases
  - Asbestosis
  - Silicosis
  - CWP
- Inhaled fibers → alveolar macrophages → inflammatory process → fibrosis
- **Most important:** positive exposure
- Typically: 20-30 years after
- Classic ILD presentation
- **Biopsy** mandatory

# Asbestosis

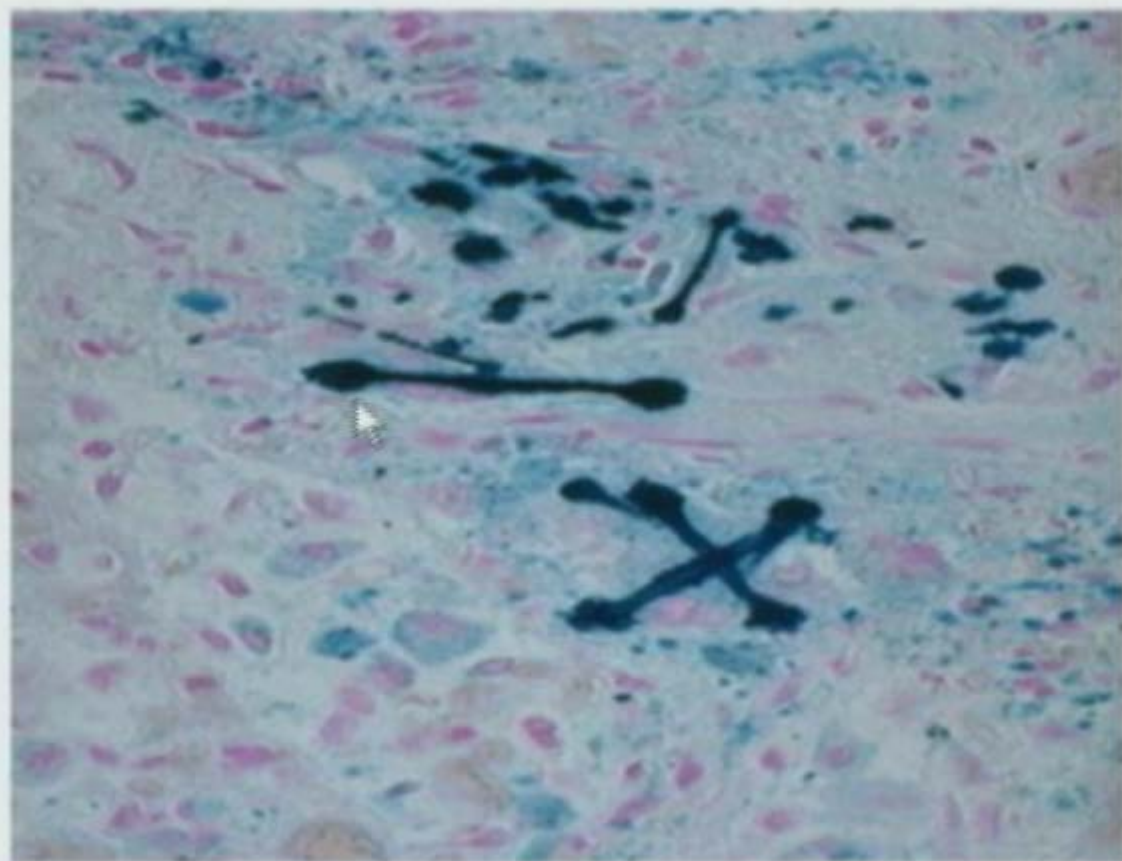
- Asbestos fiber (dumbbell)
- Associations:
  - Shipyard workers
  - Insulation
  - Brake linings
- Lower lung infiltrates
- Pleural plaques
- Risk for:
  - Bronchogenic cancer
  - Mesothelioma

## CXR: Asbestosis





# Asbestos Bodies





# Silicosis

- Silica dust
- Associations:
  - Sand blasting
  - Mining
  - Glass and pottery (quartz)
- Upper lung infiltrates
- Nodular pattern, eggshell calcifications
- Risk for pulmonary tuberculosis

## CWP

- Coal dust
- Associated with type of coal (“hardness”)
- Upper lung fields
- Small round densities
- Associated immunologic abnormalities:
  - IgA increased
  - IgG increased
  - C3 decreased
  - ANA +



## PULMONARY THROMBOEMBOLISM

## Thromboembolism Case

A 32-year-old woman comes to the ED with acute SOB and pleuritic chest pain.

She takes only oral contraceptives and has no significant PMHx.

RR 26, P 107

PE: Lung and heart exams are unremarkable.

ABG: 7.52/25/70/93%

Chest x-ray is unremarkable.

## General Concepts

- Prox. DVT = PE
- Distal DVT significant >>> prox. DVT
- Exceptions to above:
  1. Pregnancy-related DVT
  2. Upper extremity DVT
- Paradoxical thromboembolism
- Treat prox DVTs as if PE
- Natural course of a lower extremity DVT

## High-Risk Patients

- Recent surgery, especially orthopedic
- Cancer
- Immobility (economy class syndrome)
- Acquired thrombophilia
  - Lupus anticoagulant
  - Nephrotic syndrome
  - Oral contraceptives
- Inherited thrombophilia
  - Factor V Leiden
- Pregnancy

## Consistent Symptoms

- Sudden onset of dyspnea
- Thigh or calf swelling
- Pleuritic chest pain
- Hemoptysis (no prior lung Hx)
- Vitals **ALWAYS:**
  - Tachypnea
  - Tachycardia



# General Tests

- **ABG**
  - Hypoxemia and increased A-a gradient
  - Normal in healthy young patients
- **Chest x-ray**
  - Normal
  - Effusion
  - Westermark sign, Hampton hump
- **ECG**
  - Sinus tachycardia
  - S1, Q3, T3

# Specific Tests for PE

## 1. Spiral CT scan

- Allows direct visualization
- Alternative diagnoses
- May miss small peripheral PE

## Specific Tests for PE (cont.)

### 2. Ventilation perfusion scan (V/Q)

- High, intermediate, low, or normal
- Typically perfusion defects with nl ventilation
- Pre-existing lung disease = intermediate
- Normal V/Q scan = 0% PE

### 3. Angiogram

- Gold standard

## Other Testing

- Tests specific for DVT:
  - Compression or duplex ultrasound
  - Venogram
  - MRI
- Tests for both PE and DVT:
  - **D-dimer:**
    - Most sensitive
    - Due to increased FDPs
    - Not specific, only use to R/O
    - Use in low-risk patients
    - ELISA

# Diagnostic Concepts

- **Start anticoagulation** while completing diagnostic testing.
- Start with spiral CT
  - (+) then 100% PE
  - (–) then consider peripheral PEs
- In low-risk patients:
  - nl CT + nl d-dimer = no PE
  - nl ultrasound + nl d-dimer = no PE

## Diagnostic Concepts (cont.)

- In high-risk patients:
  - If tests are negative → angiogram
- V/Q scan normal = no PE
- Use ultrasound before going for the angiogram.

## Thromboembolism Case

A 32-year-old woman comes to the ED with acute SOB and pleuritic chest pain. She takes only oral contraceptives and has no significant PMHx.

RR 26, P 107

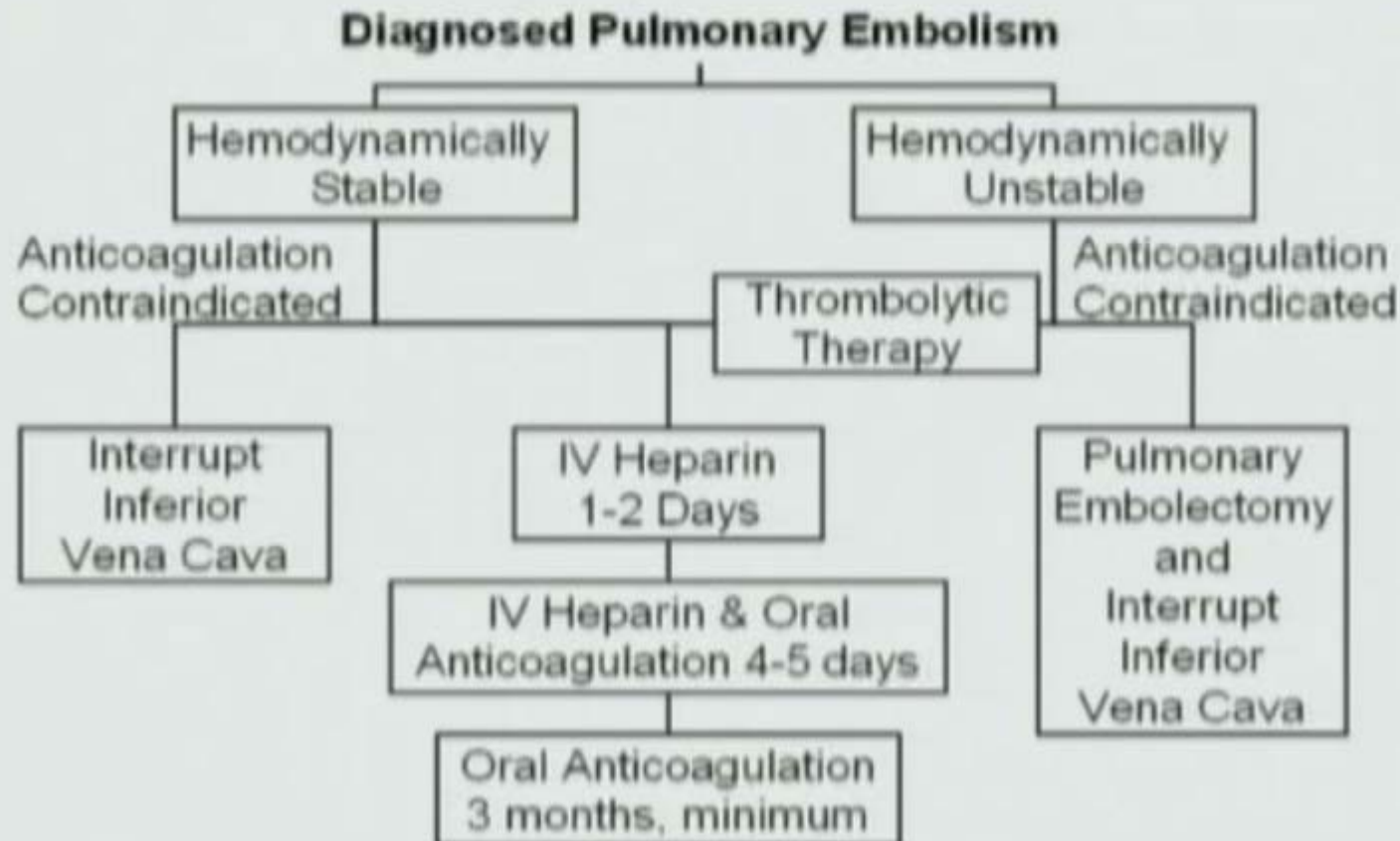
PE: Lung and heart exams are unremarkable.

ABG: 7.52/25/70/93%

Chest x-ray is unremarkable.



# Management of Diagnosed Pulmonary Embolism



## Treatment (cont.)

- O<sub>2</sub>
- Start heparin and Coumadin®
- Continue Coumadin® over 6 months
- Complications:
  - HIT
  - Bleeding
  - Warfarin skin necrosis
- Contraindications:
  - Recent major surgery: eye, central nervous system
  - IVC filter

## Treatment (cont.)

- Pregnancy-related thromboembolism
- Thrombolytics
- Thrombectomy
- Compression stockings
- Life-long anticoagulation
- Recurrent thrombosis while on anticoagulation

## Heparin-Induced Thrombocytopenia

- Occurs 5-7 days after Tx with heparin
- Occurs with both LMWH and unfractionated
- Paradoxical effect: thrombosis
- Stop ALL heparin when platelets decrease by 50%.
- May use new anticoagulants:
  - Argatroban
  - Lepirudin

## HIT Case

A 32-year-old woman is being treated for proximal DVT.

She is on day 6 of LMWH and Coumadin®.

She reports increased swelling in her calf and new-onset dyspnea.

On PE she is hemodynamically stable but her RR is 28. Lung exam is unremarkable.

Platelets: 35,000 (from 220,000)

# Thrombophilias (Hypercoagulable States)

- Factor V Leiden mutation
- Protein C deficiency
- Protein S deficiency
- Antithrombin III deficiency
- Lupus anticoagulant (antiphospholipid antibody syndrome)
- Hyperhomocysteinemia
- Prothrombin mutation



# Pregnancy and Thrombosis

- Thrombogenic potential of pre-existing diseases increases
- Pregnancy-related changes
  1. Resistance to protein C
  2. Protein S activity decreases
  3. Fibrinogen and factors II, VII increase
- Presentations:
  - DVT, PE
  - Fetal loss
  - Stillbirth



# Fat Embolism

- Occurs 3-4 days after long bone fractures
- Rarely after CPR
- Presentation:
  1. Acute dyspnea
  2. Petechiae: neck and axilla
  3. Confusion
- Tx:
  - Supportive
  - NO anticoagulation

**KAPLAN**

MEDICAL

**ADULT RESPIRATORY DISTRESS  
SYNDROME (ARDS)**

## ARDS case

A 32 year-old man is admitted to the ICU with gram negative sepsis. He is started on double gram negative antibiotic coverage and remains stable. The blood cx's grow pseudomonas sensitive to the antibiotics. Initially the patient seemed to improve but during the 2nd day he develops severe dyspnea and hypoxemia. Diffuse crackles are noted on exam and the chest x-ray shows diffuse alveolar densities (the admission chest x-ray was unremarkable).

## ARDS

- Incr. alveolar –capillary permeability
- Non-cardiogenic pulmonary edema
- Hypoxemia
- Etiology:
  1. Sepsis
  2. Trauma
  3. DIC overdose
  4. Any severe disease
- Occurs within 5 days, usually within 24 hours

# ARDS

- Findings:
  1. Dyspnea
  2. Crackles and rhonchi
  3. Hypoxemia +/- hypercapnea
- X-ray: 'white-out'
- Elevated pulm. art pressure
- Tx:
  1. Treat primary disorder
  2. Mechanical support



**SLEEP APNEA**

# Sleep Apnea

- **Obstructive** vs. central
- Cessation of airflow 10-15 times/hour
- O<sub>2</sub> saturation decreases
- Pulmonary pressure increases
- Daytime somnolence
- HTN, cor pulmonale
- Labs: increased bicarbonate
- Dx: polysomnography
- Tx: weight loss, CPAP





## LUNG CANCER

## Lung Cancer Case

A 65-year-old man is admitted because of headache and blurry vision over 3 days.

During the examination, you notice neck vein distention and darker skin color on his face than his body. He is confused.

The chest x-ray reveals a right upper lobe mass and the serum calcium is elevated.

# General Concepts

- Leading cause of death from cancer
- 90% related to smoking
- ALL lung cancers are associated with smoking!
- Nonsmoker = adenocarcinoma
- Smokers have a 10 times higher risk than nonsmokers
- Smoking cessation decreases the risk but never to a nonsmoker.
- NO screening test

# Bronchogenic Cancer: Types

- **Squamous (c)**
  1. PTH-like hormone
- **Small-cell (c)**
  - Paraneoplastic syndromes
    - SIADH
    - Cushing syndrome
    - Lambert-Eaton syndrome
- **Large-cell (p)**
- **Adenocarcinoma (p):**
  - Bronchoalveolar

# Bronchogenic Cancer: Presentation

- Cough (most common Sx)
- Weight loss, dyspnea
- Hemoptysis
- **Recurrent pneumonia**
- Hoarseness
- **SVC syndrome**
- **Pancoast syndrome**
- **Horner syndrome**
- **Effusion**

# Diagnosis

- Sputum cytology
- Bronchoscopy for central lesions
- Needle Bx for peripheral
- Cytology after effusion drainage
- Mediastenoscopy

# Management After Diagnosis

- **Is the cancer resectable?**
  1. CT scan
  2. MRI
  3. PET scan
- If the cancer is resectable, **is the patient a surgical candidate?**
  1. PFTs: FEV1 > 50% predicted
- Many patients with lung cancer have extensive COPD that makes them nonsurgical candidates.



# Nonresectable Lung Cancer

1. Hoarseness
2. Metastasis to distant organs
  - Exception: single met to brain
3. Metastasis to pleura (effusion)
4. Metastasis to other lung
5. Lesion close to the carina, main bronchus

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MEDICAL

**ATELECTASIS**

## Atelectasis Case

A 62-year-old man is dyspneic 24 hours after he underwent a cholecystectomy.

RR 22, P 112

He has a mild fever, and decreased breath sounds are noted on the left lower lobe.

CBC: 27,000 WBCs

# Atelectasis

- Collapse of part of/the entire lung
- Immediate post-operative period
- Poor inspiration
- Lack of cough
- Nonsurgery related:
  1. Cancer, foreign body
- Tachycardia, dyspnea
- X-ray: tracheal deviation
- Tx: incentive spirometry